# SFP Bi-Directional Transceiver Module for Gigabit Ethernet

## FEATURES

- **RoHS compliant**
- **Small Form-factor Pluggable (SFP) MSA compliant**
- **Simplex LC connector with 1490nm Transmitter and 1310nm Receiver**
- **Single + 3.3V power supply and TTL logic interface**
- **Support Commercial and Industrial temperature range**
- **Bellcore GR-468 compliant**
- **Laser class 1 product which comply with the requirements of IEC 60825-1 and IEC 60825-2**

## Description

The SPBD-1250xxxx series are hot pluggable 3.3V Small-Form-Factor (SFP) Bi-Directional transceiver module designed expressly for high-speed communication applications that require rates of up to 1250Mbit/sec. It is compliant with the Gigabit Ethernet standards, as well as the SFP Multisource Agreement (MSA).

The SPBD-1250xxxx transceivers provide with the LC receptacle that is compatible with the industry standard LC connector. The transceiver is also compatible with industry standard RFT connector and cage. It also includes a LOS (Loss Of Signal) circuit that provides a TTL logic-high output when an unusable optical signal level is detected.

The module includes un-cool DFB laser, InGaAs PIN, Preamplifer and WDM filter in a high-integrated optical assembly for high-density system application. The SFP Bi-Directional transceiver can upgrade transmission capacity very convenient without installing new fibers.

## Application

- IEEE 802.3ah 1000BASE-BX10
- Gigabit Ethernet Application
- FTTx WDM Broadband Access
- Switch to switch/backbone interface

## Performance

- Data link up to 10km in 9/125um single mode fiber.

## 1. Absolute Maximum Ratings

| Parameter | Symbol | Min. | Typ. | Max. | Unit | Note |
|---|---|---|---|---|---|---|
| Storage Temperature | Ts | -40 | | 85 | ºC | |
| Storage Ambient Humidity | HA | 5 | | 95 | % | |
| Power Supply Voltage | VCC | -0.3 | | 4 | V | |
| Signal Input Voltage | | -0.3 | | Vcc+0.3 | V | |
| Receiver Damage Threshold | | +3 | | | dBm | |

## 2. Recommended Operating Conditions

| Parameter | Symbol | Min. | Typ. | Max. | Unit | Note |
|---|---|---|---|---|---|---|
| Operating Case Temperature (Commercial) | TC | -5 | | 75 | ºC | Note (1,2) |
| Operating Case Temperature (Industrial) | TC | -40 | | 85 | ºC | Note (1,2) |
| Ambient Humidity | HA | 5 | | 85 | % | Non-condensing |
| Power Supply Voltage | VCC | 3.135 | 3.3 | 3.465 | V | |
| Power Supply Current | ICC | | | 300 | mA | |
| Power Supply Noise Rejection | | | | 100 | mVp-p | 100Hz to 1MHz |
| Data Rate | | 1250 -100ppm | 1250 | 1250 +100ppm | Mbps | |
| Coupled Fiber | | Single Mode Fiber | | | | ITU-T G.652 |
| Transmission Distance | | | | 10 | km | |

Note (1). Measured on topside of case front center.

Note (2). Commercial temperature: SPBD-1250B4Q1R

Industrial temperature: SPBD-1250B4Q1RT

## 3. Specification of Transmitter

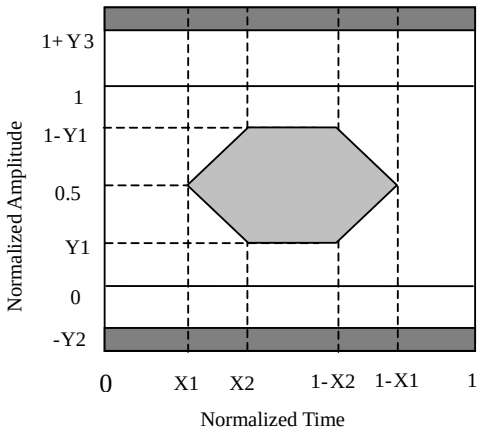
| Parameter | Symbol | Min. | Typ. | Max. | Unit | Note |
|---|---|---|---|---|---|---|
| Average Launched Power | $P_O$ | -9 | -6 | -3 | dBm | Note (1) |
| Optical Extinction Ratio | ER | 6 | | | dB | |
| Optical Modulation Amplitude | OMA | 151 -8.2 | | | uW dBm | |
| Center Wavelength | $\lambda_C$ | 1480 | 1490 | 1500 | nm | DFB Laser |
| Spectrum Width (-20dB) | $\sigma$ | | | 0.88 | nm | |
| Side Mode Suppression Ratio | SMSR | 30 | | | dB | |
| Transmitter OFF Output Power | $P_{Off}$ | | | -45 | dBm | |
| Optical Rise/Fall Time | $t_r/t_f$ | | | 260 | ps | Note (2) |
| Deterministic Jitter | DJ | | | 80 | ps | |
| Total Jitter | TJ | | | 227 | ps | Note (3) |
| Relative Intensity Noise | $RIN_{12}OMA$ | | | -113 | dB/Hz | |
| Optical Return Loss Tolerance | ORLT | | | 12 | dB | |
| Transmitter Reflectance | | | | -10 | dB | |
| Output Eye Mask *{X1,X2,Y1,Y2,Y3}* | Compliant with IEEE 802.3ah standard *{0.22,0.375,0.20,0.20,0.30}* | | | | | Note (4) |

Note (1). Launched power (avg.) is power coupled into a single mode fiber.

Note (2). These are unfiltered 20-80% values.

Note (3). Measure at $2^7$-1 NRZ PRBS pattern.

Note (4). Eye Mask definition




## 4. Specification of Receiver

| Parameter | Symbol | Min. | Typ. | Max. | Unit | Note |
|---|---|---|---|---|---|---|
| Input Optical Wavelength | $\lambda_{IN}$ | 1260 | 1310 | 1360 | nm | PIN-PD |
| Receiver Sensitivity | $P_{IN}$ | | | -20 | dBm | Note (1) |
| Input Saturation Power (Overload) | $P_{SAT}$ | -3 | | | dBm | |
| Receive Sensitivity OMA | OMA | 12<br>-19.2 | | | uW<br>dBm | |
| LOS-Deassert Power | $P_A$ | - | | -21 | dBm | |
| LOS-Assert Power | $P_D$ | -44 | | | dBm | Note (2) |
| LOS Hysteresis | $P_A$-$P_D$ | 0.5 | 2 | 6 | dB | |
| Receiver Reflectance | | | | -12 | dB | Note (3) |
| Deterministic Jitter | DJ | | | 170 | ps | |
| Total Jitter | TJ | | | 266 | ps | |
| Output Data Rise/Fall time | $t_r/t_f$ | | | 260 | ps | Note (4) |

Note (1). Measured with $\lambda_{IN}$, ER=6dB; BER =<$10^{-12}$@PRBS=$2^7$-1 NRZ

Note (2). When LOS asserted, the data output is Low-level (fixed)

Note (3). When the terminal is viewed from the optical path, the reflection toward the optical path of the optical signal with a central wavelength of $\lambda_{IN}$ transmitted to terminal.

Note (4). These are 20%~80% values

## 5. Electrical Interface Characteristics

| Parameter | Symbol | Min. | Typ. | Max. | Unit | Note |
|---|---|---|---|---|---|---|
| ***Transmitter*** | | | | | | |
| Total Supply Current | $I_{CC}$ | | | A | mA | Note (1) |
| Differential Data Input Swing | VDT | 500 | | 2400 | $mV_{p-p}$ | |
| Differential line input Impedance | $R_{IN}$ | 80 | 100 | 120 | Ohm | |
| Transmitter Disable Input-High | $V_{DISH}$ | 2 | | $V_{CC}$ | V | Note (2) |
| Transmitter Disable Input-Low | $V_{DISL}$ | 0 | | 0.8 | V | |
| Transmitter Fault Output-High | $V_{TXFH}$ | 2 | | $V_{CC}$+0.3 | V | |
| Transmitter Fault Output-Low | $V_{TXFL}$ | 0 | | 0.8 | V | |
| Transmitter Fault Pull up Resistor | $R_{TX_FAULT}$ | 4.7 | | 10 | kΩ | Note (3) |
| ***Receiver*** | | | | | | |
| Total Supply Current | $I_{CC}$ | | | B | mA | Note (1) |
| Differential Data Output Swing | VDR | 400 | | 1200 | $mV_{p-p}$ | Note (4) |
| LOS Output Voltage-High | $V_{LOSH}$ | 2 | | $V_{CC}$+0.3 | V | |
| LOS Output Voltage-Low | $V_{LOSL}$ | 0 | | 0.8 | V | |
| Receiver LOS Load | $R_{RXLOS}$ | 4.7 | | 10 | kΩ | Note (3) |

Note (1). A (TX)+ B (RX) = 300mA

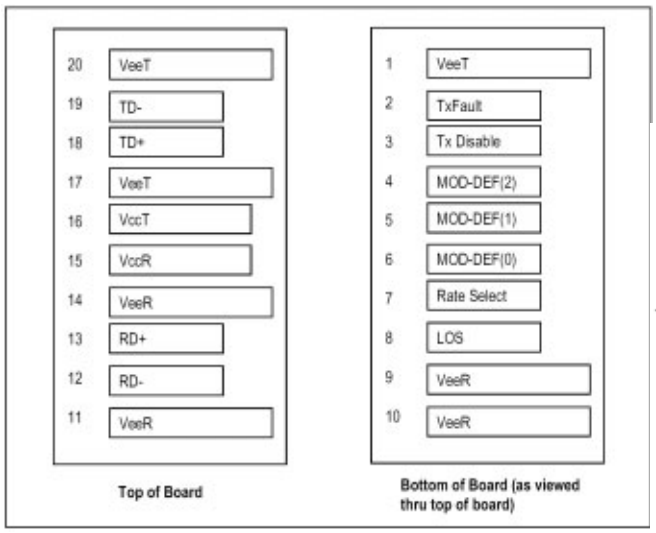
(A: Not include termination circuit; B: using a resister of 150Ω between Data-output and ground)

Note (2). There is an internal 4.7 to 10kΩ pull-up resistor to VccT.

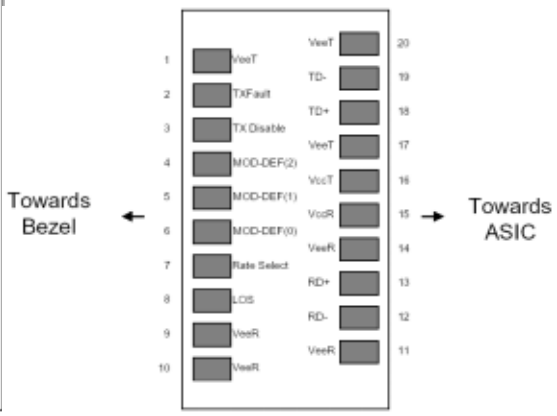
Note (3). Pull up to $V_{CC}$ on host Board.

Note (4). Internally AC coupled with CML output, but requires a 100Ohm differential termination at or internal to Serializer/ Deserializer.

## 6. Pin Description




*SFP Transceiver Electrical Pad Layout*




*Host Board Connector Pad Layout*

**Pin Function Definitions**

| Pin Num. | Name | Function | Plug Seq. | Notes |
|---|---|---|---|---|
| 1 | VeeT | Transmitter Ground | 1 | Note (1) |
| 2 | TX Fault | Transmitter Fault Indication | 3 | Note (2) |
| 3 | TX Disable | Transmitter Disable | 3 | Note (3) |
| 4 | MOD-DEF2 | Module Definition 2 | 3 | Note (4), 2 wire serial ID interface |
| 5 | MOD-DEF1 | Module Definition 1 | 3 | Note (4), 2 wire serial ID interface |
| 6 | MOD-DEF0 | Module Definition 0 | 3 | Note (4), Grounded in Module |
| 7 | Rate Select | Not Connect | 3 | Function not available |
| 8 | LOS | Loss of Signal | 3 | Note (5) |
| 9 | VeeR | Receiver Ground | 1 | |
| 10 | VeeR | Receiver Ground | 1 | |
| 11 | VeeR | Receiver Ground | 1 | |
| 12 | RD- | Inv. Received Data Out | 3 | Note (6) |
| 13 | RD+ | Received Data Out | 3 | Note (6) |
| 14 | VeeR | Receiver Ground | 1 | |
| 15 | VccR | Receiver Power | 2 | Note (7) |
| 16 | VccT | Transmitter Power | 2 | Note (7) |
| 17 | VeeT | Transmitter Ground | 1 | |
| 18 | TD+ | Transmit Data In | 3 | Note (8) |
| 19 | TD- | Inv. Transmit Data In | 3 | Note (8) |
| 20 | VeeT | Transmitter Ground | 1 | |

Plug Seq.: Pin engagement sequence during hot plugging.

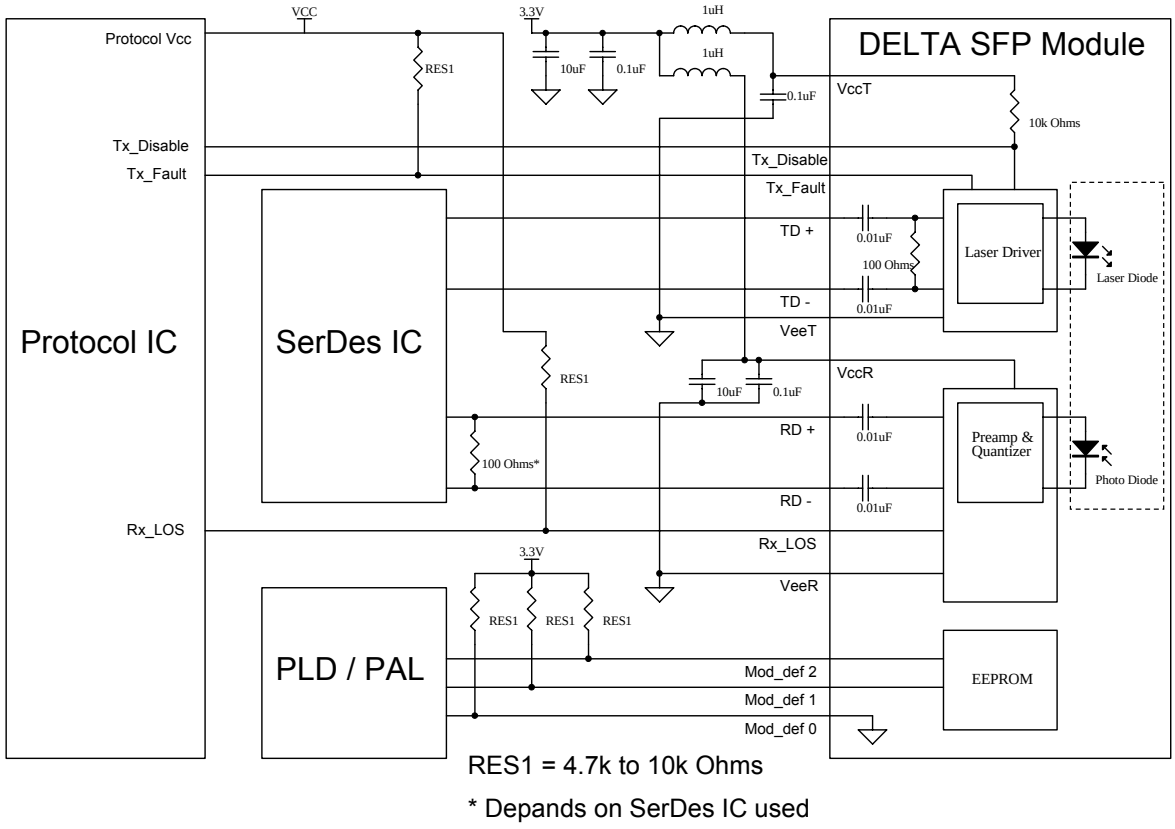
**Notes:**

1) Circuit ground is internally isolated from frame (chassis) ground. Tx GND and Rx GND may be internally isolated within the TRx module.
2) TX Fault is an open collector/drain output, which should be pulled up with a 4.7K~10KΩ resistor on the host board. Pull up voltage between 2.0V and VccT+0.3V. The output indicates Low when the transmitter is operating normally, and High with a laser fault including laser end-of-life. In the low state, the output will be pulled to less than 0.8V.
3) TX disable is an input that is used to shut down the transmitter optical output. It is pulled up within the module with a 4.7 – 10 K Ω resistor. Its states are:

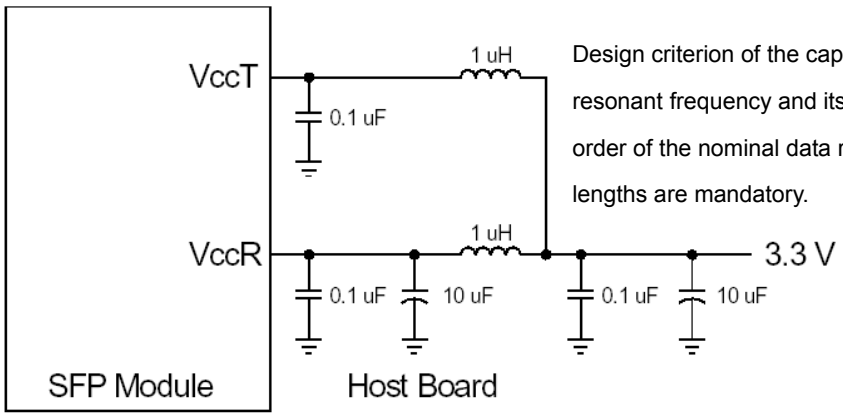
   Low (0 – 0.8V): Transmitter on
   (>0.8, < 2.0V): Undefined
   High (2.0 – 3.465V): Transmitter Disabled
   Open: Transmitter Disabled
4) Mod-Def 0,1,2. These are the module definition pins. They should be pulled up with a 4.7K – 10KΩresistor on the host board. The pull-up voltage shall be VccT or VccR.

   Mod-Def 0 is grounded by the module to indicate that the module is present
   Mod-Def 1 is the clock line of two-wire serial interface for serial ID
   Mod-Def 2 is the data line of two-wire serial interface for serial ID
5) LOS (Loss of Signal) is an open collector/drain output, which should be pulled up with a 4.7K – 10KΩ resistor. Pull up voltage between 2.0V and VccR+0.3V. When high, this output indicates the received optical power is below the worst-case receiver sensitivity. Low indicates normal operation. In the low state, the output will be pulled to less than 0.8V.
6) RD-/+: These are the differential receiver outputs. They are AC coupled 100Ω differential lines which should be terminated with 100Ω (differential) at the user SERDES. The AC coupling is done inside the module and is thus not required on the host board.
7) VccR and VccT are the receiver and transmitter power supplies. They are defined as 3.3V ±5% at the SFP connector pin. Recommended host board power supply filtering is shown below page. Inductors with DC resistance of less than 1 Ohm should be used in order to maintain the required voltage at the SFP input pin with 3.3V supply voltage. When the recommended supply-filtering network is used, hot plugging of the SFP transceiver module will result in an inrush current of no more than 30 mA greater than the steady state value.
8) TD-/+: These are the differential transmitter inputs. They are AC-coupled, differential lines with 100 Ω differential termination inside the module. The AC coupling is done inside the module and is thus not required on the host board. The inputs will accept differential swings of 500 – 2400 mV (250 – 1200 mV single-ended), though it is recommended that values between 500 and 1200 mV differential (250 – 600 mV single-ended) be used for best EMI performance.

## 7. Recommend Interface Circuit



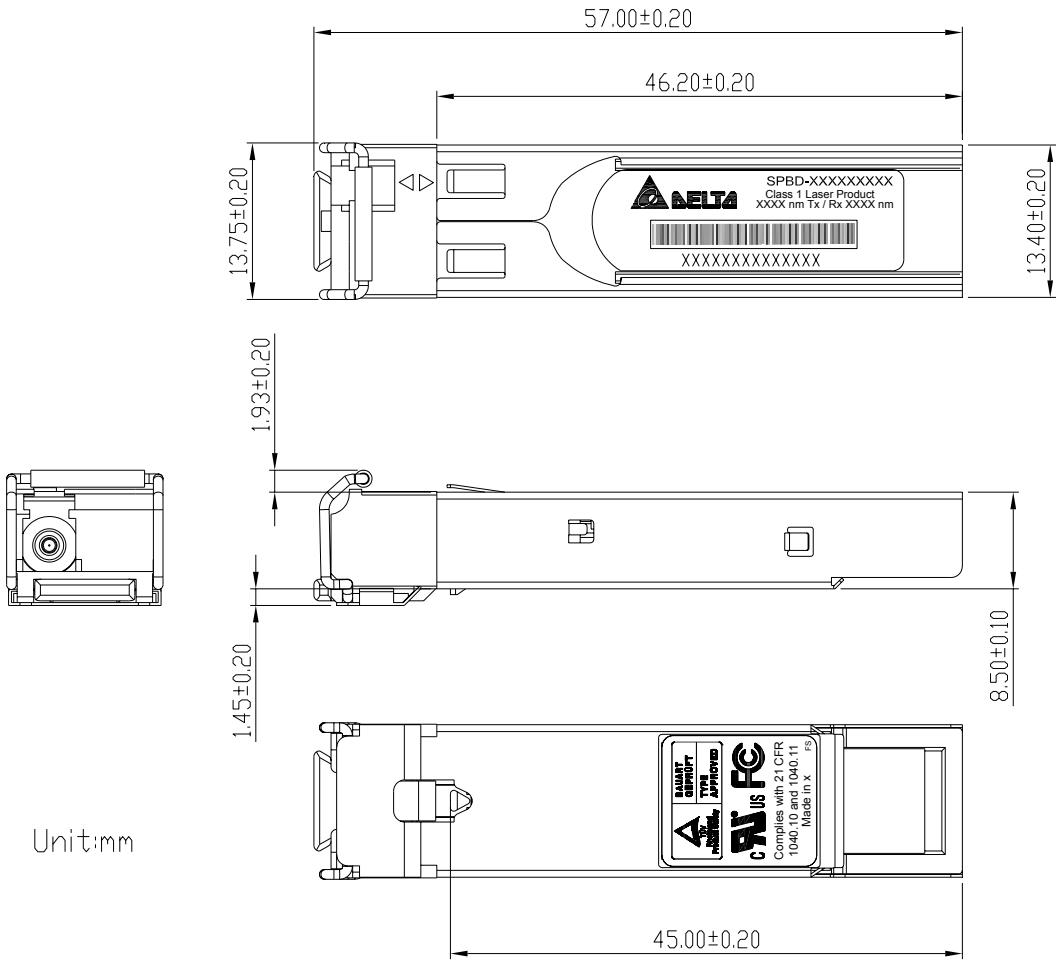

***SFP Host Board Schematic***

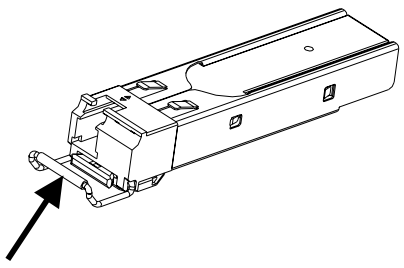



Design criterion of the capacitor used is the resonant frequency and its value must be in the order of the nominal data rate. Short trace lengths are mandatory.

***Recommended Host Board Supply Filtering Network***

## 8. Outline Dimensions



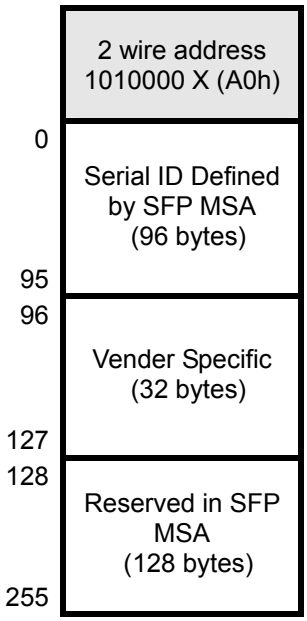



| Transmitter Wavelength | Latch Color Identifier |
|---|---|
| 1310nm | Blue |
| 1490nm | Violet |

## 9. EEPROM Serial ID Memory Contents (2-Wire Address A0h)

| Address | Name of Field | Value (Hex) | Remark |
|---|---|---|---|
| **Base ID Fields** | | | |
| 00 | Identifier | 03 | SFP transceiver |
| 01 | Ext. Identifier | 04 | Serial ID module supported |
| 02 | Connector | 07 | LC connector |
| 03 | | 00 | Infiniband Compliance Codes |
| 04-05 | Transceiver code | 00 00 | Transceiver codes |
| 06 | Transceiver code | 40 | Ethernet Base-BX10 compliance |
| 07-10 | Transceiver code | 00 00 00 00 | Transceiver codes |
| 11 | Encoding | 01 | Compatible with 8B10B GE encoding code |
| 12 | BR, Nominal | 0D | Nominal 1300 Mbps (actual GE 1250Mbps) |
| 13 | Reserved | 00 | Reserved for SFF-8079 |
| 14 | | 0A | 9/125 ìm fiber, units of km (10km) |
| 15 | | 64 | 9/125 ìm fiber, units of 100 m (10000m) |
| 16 | | 00 | 50/125 ìm fiber, units of 10 m |
| 17 | | 00 | 62.5/125 ìm fiber, units of 10 m |
| 18 | | 00 | Link length supported for copper, units of meters |
| 19 | | 00 | Reserved |
| 20 | Vendor Name | 44 | “D” (Vendor name in ASCII character) |
| 21 | | 45 | “E” (Vendor name in ASCII character) |
| 22 | | 4C | “L” (Vendor name in ASCII character) |
| 23 | | 54 | “T” (Vendor name in ASCII character) |
| 24 | | 41 | “A” (Vendor name in ASCII character) |
| 25-35 | | 20 | (Vendor name in ASCII character) |
| 36 | Channel spacing | 00 | Specify the channel spacing in units of GHz. |
| 37-39 | Vendor OUI | 00 | SFP vendor IEEE company ID |
| 40 | Vendor P/N | 53 | “S” (Vendor P/N in ASCII character) |
| 41 | | 50 | “P” (Vendor P/N in ASCII character) |
| 42 | | 42 | “B” (Vendor P/N in ASCII character) |
| 43 | | 44 | “D” (Vendor P/N in ASCII character) |
| 44 | | 2D | “-“ (Vendor P/N in ASCII character) |
| 45 | | 31 | “1” (Vendor P/N in ASCII character) |
| 46 | | 32 | “2” (Vendor P/N in ASCII character) |
| 47 | | 35 | “5“ (Vendor P/N in ASCII character) |
| 48 | | 30 | “0” (Vendor P/N in ASCII character) |
| 49 | | 42 | “B” (Vendor P/N in ASCII character) |
| 50 | | 34 | “4” (Vendor P/N in ASCII character) |
| 51 | | 51 | “Q (Vendor P/N in ASCII character) |
| 52 | | 31 | “1” (Vendor P/N in ASCII character) |
| 53 | | 52 | “R” (Vendor P/N in ASCII character) |
| 54 | | 20 or 54 | “ ” or “T” (Vendor P/N in ASCII character) |
| 55 | | 20 | (Vendor P/N in ASCII character) |
| 56-59 | Vendor Rev | 41 20 20 20 | “A” |
| 60-61 | LD wavelength | 05 D2 | (1490nm) in Hex byte |
| 62 | DWDM wavelength | 00 | |
| 63 | CC_BASE | XX | Check sum (0~62) |
| **Extended ID Fields** | | | |
| 64 | Reserved | 00 | |
| 65 | Options | 1A | (Tx_Diasble, Tx_Fault, LOS) |
| 66 | BR,max | 00 | Upper bit rate margin,units of % |
| 67 | BR,min | 00 | Lower bit rate margin,units of % |
| 68-83 | Vendor SN | XX | “DEYYWWVVRSSSSS” |
| 84-91 | Date code | XX | “YYMMDD” |

| | | | |
|---|---|---|---|
| 92 | DDM | 00 | |
| 93 | Enhanced options | 00 | |
| 94 | SFF-8472 compliance | 01 | SFF-8472 Compliance Rev.9.3 |
| 95 | CC_EXT | XX | Check sum (64~94) |
| **Vendor Specific ID Fields** | | | |
| 96-127 | Vendor Specific | 00 | Vendor Specific EEPROM |
| 128-255 | Reserved | 00 | Reserved for SFF-8079 |



## 10. Regulatory Compliance

| Feature | Test Method | Reference | Performance |
|---|---|---|---|
| Electrostatic Discharge (ESD) to the Electrical Pins | Human Body Model (HBM) | MIL-STD-883E Method 3015.7<br>EIA-JESD22-A114 | (1) Satisfied with electrical characteristics of product spec.<br>(2) No physical damage |
| | Machine Model (MM) | EIA-JESD22-A115 | |
| Electrostatic Discharge (ESD) to the Simplex Receptacle | Contact Discharge | IEC/EN 61000-4-2 | |
| | Air Discharge | IEC/EN 61000-4-2 | |
| Radio Frequency Electromagnetic Field Immunity | | IEC/EN 61000-4-3 | |
| Electromagnetic Interference (EMI) | | FCC Part 15 Class B<br>EN 55022 Class B<br>(CISPR 22A) | |
| Laser Eye Safety | FDA/CDRH<br><br>TUV | FDA 21CFR 1040.10, 1040.11<br><br>IEC/EN 60825-1<br>IEC/EN 60825-2 | CDRH File # 0420993<br><br>TUV Certificate # R50032471 |
| Component Recognition | TUV<br><br>UL/CSA | IEC/EN 60950<br><br>UL 60950 | <br><br>UL File # E239394 |

## Appendix A. Document Revision

| Version No. | Date | Description |
|---|---|---|
| S0 | 2008-09-23 | Preliminary datasheet |
| | | |